Volume 16 July, 1930 *Number 7*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Meeting the Operating Conditions of Warm Weather Driving

PUBLISHED MONTHLY BY
THE TEXAS COMPANY
TEXACO PETROLEUM PRODUCTS

TEXACO LUBRICATION CHART

KEY TO GRADES

	TEXACO GRADE	EQUIVALENT S.A.E. BODY
C	TEXACO MOTOR OIL C	S.A.E. Viscosity No. 10
D	TEXACO MOTOR OIL D	S.A.E. Viscosity No. 20
E	TEXACO MOTOR OIL E	S.A.E. Viscosity No. 30
F	TEXACO MOTOR OIL F	S.A.E. Viscosity No. 40
G	TEXACO MOTOR OIL G	S.A.E. Viscosity No. 50

IMPORTANT

S.A.E. Viscosity Numbers have been adopted by the Society of Automotive Engineers in cooperation with the automotive and petroleum industries with the intention of eliminating confusion by furnishing a uniform classification of motor oils according to viscosity or body. These viscosity numbers are not a specification and in no way guarantee quality or degree of refining. Texaco Motor Oils meet fully S.A.E. Viscosity gradings but in addition have quality characteristics that make them outstanding motor oils.

PASSENGER CARS

NAME AND MODEL	Column A Atmospheric Temperatures Above 70° F.	Column B 35° to 70° F.	Column C 0° to 35° F.
Auburn 6-85	G	F	D
8-95	F	F	D
125	G	F	D
others	G	F	D
Austin, The American	G	F	E
Black Hawk 6	G	F	E
8	G	F	E
Buick 40	F	E	D
50-60	F	E	D
1931 models and others	F	E	D
Cadillac 8 cyl. (353)	G	F	E
16 cyl. (452)	G	F	E
others	G	F	E
Chevrolet	F	E	D
Chrysler 6	F	E	D
66	F	E	D
70	G	E	D
77	G	E	D
Imperial	G	E	D
1931 models and others	G	F	D
Citroen	G	F	E
Cord (front drive)	G	F	E
Cunningham V9	F	E	D
others	G	F	D
Daimler	G	F	E
DeDion	G	E	D
De Soto 6	F	E	D
8	F	E	D
Diana	F	E	D
Dodge 6	F	E	D
8	F	E	D
Duesenberg J	G	F	D
others	G	F	D
duPont G	F	E	D
others	F	E	D
Durant 6-14	F	E	D
6-17	F	E	D
others	F	E	D
Elcar 6 cyl. 75-A	F	E	E
8 cyl. 95, 96	F	E	D
8 cyl. 130, 140	F	E	D
others	F	E	D
Erskine	E	E	D
Essex 6 cyl.	F	E	D
others	F	E	D
Falcon*	F	E	D
Fiat	G	F	D
Flint	F	E	D
Ford A	G	F	D
T	F	E	D
Franklin 145-147	G	F	D
others	G	F	D
Gardner, Front Drive	G	F	E
6 cyl.	G	E	D
8 cyl.	G	F	D
others	F	E	D
Graham 6 cyl.	G	F	E
8 cyl.	G	F	D

[Continued on Inside Back Cover]

IN MAKING these recommendations Texaco lubricating engineers enjoyed the fullest cooperation of motor vehicle manufacturers.

These recommendations are based on the assumption that driving speeds are not excessive and engines are in mechanically good operating condition. Mechanical faults such as worn pistons and loose bearings cannot be corrected with oil although frequently the use of a heavier grade will offer temporary relief.

The recommendations under Columns A, B and C are based on atmospheric and not on crankcase operating temperatures and in general apply as follows:

COLUMN A — recommendations apply in southern climates generally throughout Spring, Summer, Fall; and in northern climates throughout hot summer months, particularly under hot engine and hard driving conditions.

COLUMN B — recommendations apply in southern climates during winter weather and in northern climates when temperatures are above freezing.

COLUMN C — recommendations listed under Column C apply generally where temperatures are below freezing but not below zero.

SUB-ZERO—Where temperatures average below 0° F., as in extreme northern climates and in Canada, Texaco Motor Oil C should generally be used, though oils listed in Column C may be used for make-up.

LUBRICATION

A Technical Publication Devoted to the Selection and Use of Lubricants

Published Monthly by

The Texas Company, 135 East 42nd Street, New York City

Vol. XVI | July, 1930 | No. 7

Change of Address: In reporting change of address kindly give both old and new addresses.

Meeting the Operating Conditions of Warm Weather Driving

PRESENT day practice in motoring has developed into a matter of expecting an automobile to be as mechanically perfect as possible, with but negligible thought and care on the part of the owner or operator.

For years the development of this mechanical perfection has been the goal of the automotive engineer. This goal has been attained to a remarkable extent. It must not be forgotten, however, that once attained this degree of perfection can only be assured through the co-operation of the petroleum industry, for it is to this industry that the motorist must turn for the products which will keep his car on the road.

It is in a realization of this fact that the research authorities of the petroleum industry have studied the protection of automotive equipment with the greatest care. They have anticipated the desire of the motorist to be relieved of the worries which used to accompany the operation of any such vehicle in regard to the possibility of roadside break-down. It is easy to recall the extent to which this latter used to occur but a few years ago. It was especially prevalent where intensive operation might be encountered, as for example in warm weather, for such conditions impose an added duty upon any piece of machinery which can only be overcome by proper lubrication.

The complete attainment of maximum and dependable power output, however, involves more than lubrication. We must consider the gasoline and the extent to which the carburetor or firing system is adapted or adjusted to its characteristics, and the extent to which the lubricating oil is maintained in a sufficient degree of cleanliness. In this regard, it is well to state that effective lubrication can only be maintained by providing means which will insure that the degree of purity of the oil will be as close as possible to its original degree of refinement.

There is an additional factor, however, which must not be overlooked. Probably one of the most essential elements in warm weather driving is bringing about as complete engine cooling as possible. It is important, of course, that complete combustion be attained whatever the driving conditions and that lubrication be so positive as to insure against any possibility of the development of abnormal friction or wear. These are conditions, however, which are materially influenced by the manner in which the car is handled by the driver and the care and attention which he gives to maintaining the oil at the proper level and to renewing it at periodic intervals.

There are certain important developments in design which have recently been adopted, however, which have enabled the manufacturers of automobiles to aid their subsequent operators in this matter of engine cooling. These involve engine head design, the installation of dual ignition systems, the use of an oil cooler, the adoption of means to prevent carbon formation and, in the air cooled engine, the design of the cooling fins to insure more uniform radiation of heat.

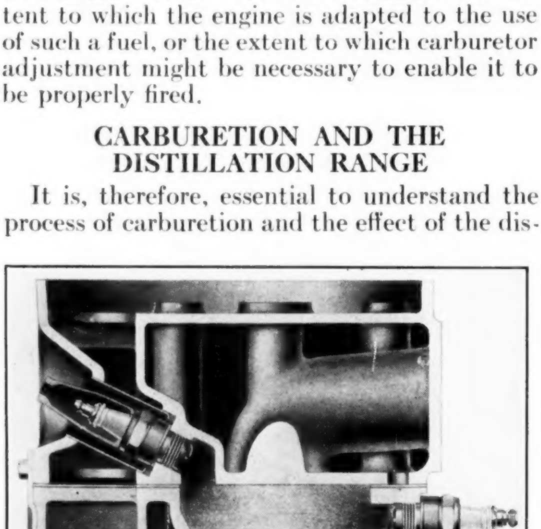
Certain of these constructional details are shown in the accompanying illustrations. They have been explained in detail but it may be well to mention that with the exception of the oil cooler they all lead to the improvement of combustion and the elimination of knock, which are, of course, the primary requisites apart from the actual cooling system in the maintenance of more steady and reduced engine operating temperatures, especially under intensive conditions of operation.

Gasoline Requirements and Characteristics

The extent to which gasoline as an automotive fuel has been improved over the past few years, and the relation which this improvement has upon the operating performance of the average automotive engine will render it advisable to discuss the characteristics which should be clearly understood by the motorist. There is more to the purchase of gasoline than simply relying on the assurance that we are obtaining a product capable of developing a maximum of power or one which has been blended or otherwise refined to increase its anti-knock value. We must consider the extent to which the engine is adapted to the use of such a fuel, or the extent to which carburetor adjustment might be necessary to enable it to be properly fired.

CARBURETION AND THE DISTILLATION RANGE

It is, therefore, essential to understand the process of carburetion and the effect of the distillation range. Effective carburetion is in fact contingent upon this latter and the carburetor must be adjusted to conform to the distillation range of the gasoline to be used. This does not mean, however, that any carburetor can be adjusted by following a specific rule, according to the starting temperature or end point of the gasoline. Experience of carburetor authorities, and they, in general, should be the only ones who should attempt carburetor adjustment, will indicate that for certain blends of gasoline or with the straight run variety, a certain amount of jet adjustment can be made according to the tone of the engine and its ability to develop power.



Courtesy of The Nash Motors Company

Fig. 1—Showing the twin-ignition arrangement used in the new Nash 8 and 6 engines. The purpose of this design is to coordinate high compression and enable the spark flame to develop extra power, speed, smoothness and economy. This is also an advantage in maintaining more even engine operating temperatures.

It will be especially advisable to adjust in this manner for warm weather driving, for one must realize that warm weather will involve the vaporizing characteristic of a gasoline, and very frequently the temperature of the carburetor will be very nearly the same as the so-called initial boiling point or starting temperature of the fuel.

In this connection, however, it must be borne in mind that this apparent boiling point is really the condensing point of the first fraction. The actual temperature of the fuel in the first fractions may be 40 or 50 degrees higher than the so-called initial boiling point. It should also be remembered that the temperature at the carburetor may be much higher than the atmospheric temperature. If the actual temperature of the carburetor system is higher than the initial boiling point of the liquid gasoline, gas may be formed in the line, which is the cause of vapor lock.

As a result, if the carburetor is not properly adjusted to reduce the richness of the mixture it may lead to difficulty in starting and may cause stalling if the engine idles for any length of time.

Complete Vaporization Essential

The extent to which vaporization of liquid gasoline will occur and the rate of gasification will vary directly with the temperature of the air into which this gasoline is injected. In actual practice this will mean that on a cold day the amount of liquid gasoline which will pass to the engine will be greater in proportion to the amount of gas developed. As an illustration of this, if a gasoline were to be injected into the air, contingent upon the temperature

of this latter, the gasoline would not evaporate immediately, but would have the appearance of a fog, in which a considerable number of very minute drops of liquid would be suspended. If the temperature of the air is raised, however, a point will be reached where the gasoline will pass very rapidly into the gaseous state.

This matter of rapidity of vaporization is a decided adjunct in the development of maximum power in an automobile engine, for in the carburetor there is but a small fraction of a second involved between the time the gasoline reaches the jet until it enters the cylinders. In consequence, the lighter or more volatile the fuel the more readily will it pass into the gaseous state and the more easily will it lend itself to mixing with the air and consequent complete combustion.

The Distillation Test

As a result, gasoline is evaluated by means of the distillation test. This comprises heating of a measured sample in a flask at atmospheric pressure. When a temperature of about 100 degrees Fahr. is reached above the liquid (not in the liquid), vaporization begins.

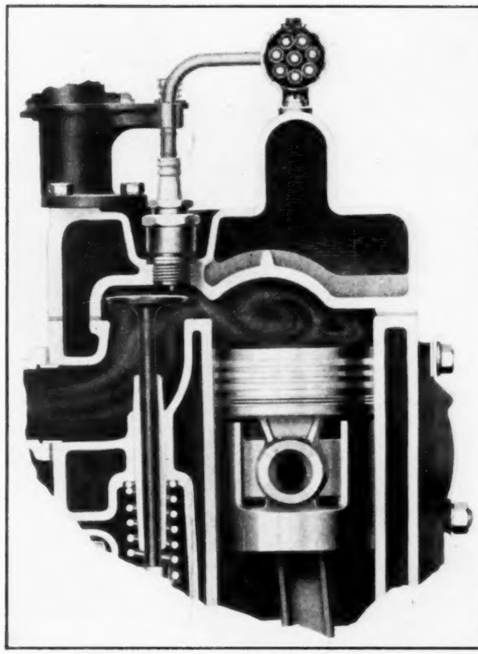
The temperature at which the first condensable vapors are produced is called the "initial boiling point." The temperature is then gradually raised to result in more and more gasoline passing off as vapor, until a vapor temperature of somewhere around 400 degrees Fahr. is reached, when, with the best gasoline, practically all will have been vaporized. This is called the "end point."

The carburetor technologist, in considering the action of his carburetor, looks at another point in addition to the "initial boiling" and "end point," and that is the average distillation range. In actual carburetor operation it has been found that gasoline may not vaporize in strictly the same manner as it does from a distillation flask, because vaporization of gasoline from the carburetor takes place in the presence of a large proportion of air, and the gasoline will go into the gaseous state at a much lower temperature than is exhibited with a standard distillation flask in the laboratory.

The vaporization of water is an example of this phenomenon. Here vaporization in a flask will not occur until a temperature of 212 degrees Fahr. is reached, yet water will vaporize perfectly in a current of air at a much lower temperature.

Heat a Necessary Factor

Any liquid requires heat to make it pass into the gaseous state. In the automobile engine this heat cannot be applied by a flame, as is customary in laboratory distillation testing; therefore, it must be absorbed from the air into which the gasoline is vaporized. On the other hand, when the gasoline goes through the carburetor jet it cools the incoming air. A good example of this is the cooling effect that water



Courtesy of Marmon Motor Car Company

Fig. 2—Sectional view of the new double dome combustion chamber for the new Marmon Big Eight. The design of the combustion chamber enables more complete combustion, which leads to elimination of fuel knock and smoother engine operation.

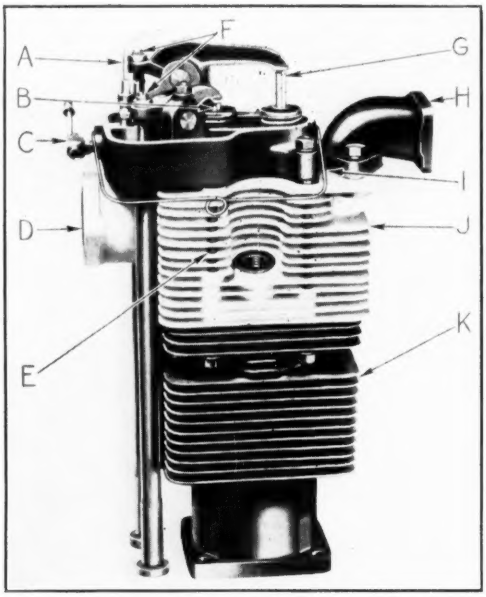
has when it vaporizes from your hand in a current of air.

In consequence, we have two factors more or less balancing each other, viz.: the lowering of the temperature of the air, which tends to decrease the rate of vaporization, and the large volume of air, which tends to increase it. In actual operation it has been developed that the latter has a greater effect than the former, so complete vaporization or gasification of the fuel is attained at temperatures considerably below 400 degrees Fahr.

In addition to the above, however, manifold systems generally provide for application of heat to the vaporized mixture of air and fuel before it enters the cylinders, and furthermore, after such entry we must remember that there is quite a volume of hot burned gases available with which the air-vapor combination mixes in the cylinder, which in turn will also tend to drive any remaining liquid gasoline into the gaseous state. The more thoroughly this can be accomplished before the fuel charge enters the cylinder, the less pre-heating will be required to bring about complete combustion. It is for this reason that the more volatile a

gasoline and the lower the average distillation temperature, the quicker will be the response on starting and acceleration.

It must be borne in mind, however, that when starting there is no hot spot available to



Courtesy of Franklin Automobile Company

Fig. 3—View of Franklin cylinder, showing horizontal fin arrangement. A illustrates the valve lubricator drip pipe, B the exhaust valve, C the valve lubricator resistance tee, D the exhaust port, E the compensating stud, F the valve adjusting screws, G the intake valve, H the intake port, I the valve walking beam case cover clamp, J the cylinder head, and K the cylinder.

serve as a preheater for the gasoline vapor, and frequently when rapid acceleration is required there will be a sudden call for fuel mixture, which may not always have time to become properly heated before it is called on to work.

From the above it would seem that the lighter the gasoline or the more easily it will vaporize, the better the product, but we must remember that after the car has been run a while everything has been thoroughly heated up, and if the gasoline vaporizes too easily before it gets to the jet in the carburetor it may cause unsatisfactory operation due to vapor lock. As a result, it is essential that vaporization shall not commence at too low a temperature.

"End Point" Also Important

The "end point" has an effect on the average distillation temperature of the fuel, as well as the amount of heavy ends or less volatile fractions that are retained by the lubricating oil on the cylinder walls.

There is considerable discussion as to how these heavy ends get into the lubricating oil; some authorities claim that they comprise unvaporized gasoline that is drawn into the cylinder, and subsequently thrown into contact with the lubricating film by turbulence. Others have developed that even gasified fuel, when sweeping across a lubricating film, will be absorbed to a certain extent.

Regardless of the mechanism, the fact remains that it does get into the lubricating oil, and will not leave it unless the temperature in the crankcase is raised around 175 degrees Fahr. Furthermore, it has been fairly well proven that the greater the average temperature of the upper distillation range, the greater the crankcase dilution. As a result, the better the vaporization before the fuel-air mixture reaches the intake manifold, the better and more even will be the distribution, the lower the rate of crankcase dilution and the more dependable the degree of lubrication.

SULFUR MUST BE CONSIDERED

An extremely important factor to consider, both in the manufacture and usage of automotive fuels, is the element sulfur. As petroleum crude oils are received in the refinery they may or may not carry a comparatively high sulfur content. This will all depend on their source.

The sulfur content of crude oils will vary widely. Where relatively high, the subsequent sulfur content in any gasoline derived therefrom may be proportionately high.

In the process of refining, a certain amount of sulfur compounds are included in the finished gasoline.

Sulfur in motor fuels must be viewed from two angles:

a. The total sulfur content of the gasoline;
b. That part of the total sulfur content which is or may be corrosive.

Corrosive Sulfur

The presence—or absence—of corrosive sulfur in gasoline is indicated by the Corrosion Test.

This test, which should be performed on every finished gasoline before it is put on the market, according to the A. S. T. M. "shall be used for the detection of free sulfur and corrosive sulfur compounds in gasoline."

The procedure as recommended by the A. S. T. M. (Serial Designation D 130-27 T) is as follows:

> A clean strip of mechanically polished pure sheet copper about one-half inch in width and three inches in length shall be placed in a suitable clean tube or sample bottle. Gasoline under test shall be added so that the copper strip is completely immersed. The test tube or sample bottle shall be closed with a loosely fitting cork and held in a suitable bath at 122 degrees Fahr. (50 degrees C.) At the end of three hours

the gasoline exposed strip shall be removed and shall be compared with a similar strip of freshly polished copper.

Detection of Sulfur

The presence of sulfur or corrosive sulfur compounds is indicated by the corrosion or discoloration of the gasoline exposed strip when compared with the fresh copper strip.

(a) Gasoline shall be reported as passing the test when on examination the exposed strip shows not more than extremely slight discoloration as compared with the fresh copper strip.

(b) Gasoline shall be reported as not passing the test when on examination the exposed strip shows more than extremely slight discoloration as compared with the fresh copper strip.

The "Doctor Test"

The "doctor test" embodies agitation of a certain volume of gasoline with a caustic soda solution of litharge. A so-called "sweet" gasoline should show no reaction when so treated.

Certain compounds will react with this solution forming a black precipitate and causing discoloration of the gasoline. A gasoline which does not pass the "doctor test" may, nevertheless, not be corrosive and, as a result, this test is more or less subsidiary to the Corrosion Test, which is today taken as the final indication of corrosive sulfur content in gasoline.

The Prevailing Reactions

In the process of combustion of gasoline oxidation of sulfur will bring about the formation of sulfur dioxide (SO_2). This latter is a gas of highly reactive tendencies in the presence of water. In view of the amount of water which is developed during combustion, its ultimate reaction with sulfur dioxide to form sulfurous acid (H_2SO_3) is a normal consequence.

In other words, we have the genesis of corrosion, for while sulfurous acid is comparatively weak, it is also unstable from the viewpoint of oxidation, i.e., it can be ultimately expected to take up one more atom of oxygen to bring about the formation of sulfuric acid (H_2SO_4). The extent to which engine bearings and other wearing elements may be damaged will, of course, depend on how continuously such fuels are used, and the degree of seal which is being maintained by the piston rings.

Operating Conditions Affect Condensation

The operating conditions, however, must be taken into account. If, for example, comparatively continuous operation prevails, as in the case of motor transport equipment, the maintenance of the engine in heated condition will preclude development of condensation to any appreciable extent. As a result, the possibility of moisture and subsequent reaction of this latter with any sulfur in the gasoline will be minimized.

Sulfur as a constituent of straight distilled gasoline, or of benzol will normally be present as a more or less complex compound of the other chemical elements involved. Rarely will it occur as essentially free sulfur.

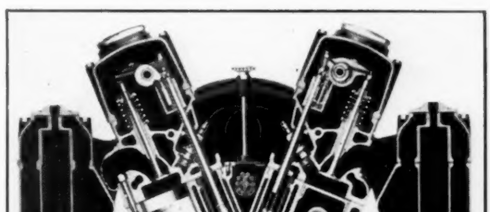
With certain blended gasolines, it may be necessary to operate with a sulfur content much higher than that of normal highly refined gasoline. This will be especially true where benzol is used in compound for the purpose of improving anti-knock qualities in the resultant gasoline.

Low Temperatures Promote Corrosion

Research has developed that corrosion due to sulfur reactions will probably occur more readily in cold weather, due especially to the greater possibility of abnormal condensation of water vapor developed in the process of combustion. It is logical to presume, therefore, that effective means for reduction of condensation will reduce the possibility of active chemical reaction with sulfur.

THE DETRIMENTS OF WATER

Water in the crankcase or oil sump of an automotive engine will be conducive to rust, emulsification and sludge formation. This will be especially true where road dust, dirt, carbon or metallic particles have been allowed to accumulate to any extent. This can be prevented to a certain degree by an oil filter and air filter.



Courtesy of Cadillac Motor Car Company

Fig. 4—Sectional view of a Cadillac V type 16 cylinder engine, showing crankcase breather and details of cylinder and piston construction.

Above all, however, especially in cars not equipped with these accessories, it is important to remember that periodic changing of oil and careful flushing of the crankcase and lubricating system will be most advisable in the interest of prolonging the life of bearings and piston rings,

Courtesy of Marmon Motor Car Company
Fig. 5—Showing radiator shutter control on the new Marmon 8-79. This is controlled by the thermostatic mechanism as shown.

the prevention of undue wear on cylinder walls, and the assurance of more dependable operation.

How Water is Developed

Just how water may gain entry into such a carefully built and enclosed machine as an automotive engine will be of interest. The possibility of entry from an external source is remote, provided reputable gasoline and motor oil are used which can be depended upon to be water-free. It will usually be developed within the engine itself, as a product of combustion or condensation. In this connection, it is interesting to note that virtually as much water vapor is developed in the process of combustion as there is fuel consumed.

The amount which will actually reach the crankcase to mix with the oil therein will, of course, depend on how effectively the piston rings and lubricating film function in the maintenance of a suitable seal. It would be unwise to attempt to give a figure in pints of water for example, per gallon of gasoline, or per hour of operation, for there are too many variables involved.

The presence of water as a product of combustion can be realized by holding a glass receptacle over the end of the exhaust. The exhaust as it passes to the air is usually gaseous in form, though a certain amount of condensation may occur, due to contact with the colder surfaces of the muffler.

In gaseous form water cannot be as readily observed; hence the idea of using a glass to serve as a crude condenser. After a few minutes of this collection of the exhaust, drops of water can be actually noted on the walls of the container. The colder the latter the more rapidly will condensation occur.

This is exactly what takes place within the engine also, but, of course, to a far less degree, for the majority of the exhaust is naturally carried out through the muffler except in an engine where the piston seal is poor. At all events, however, some of this exhaust with its vaporous water content may pass to the crankcase, and the cooler the latter the more readily will subsequent condensation occur.

The extent to which this may occur to contaminate the lubricating oil, however, will depend upon the condition of the engine. In other words, where piston rings are worn or cylinder walls scored or abraded to result in abnormal clearance, an effective seal cannot be as readily maintained by the lubricating oil as in an engine where the proper clearance exists between the pistons and cylinder walls.

High clearances will be conducive to leakage. This may involve loss of compression due to blow-by or leaking of combustible fuel vapor on the explosion stroke; as well as the possibility of water leakage past the piston rings and into the crankcase.

Condensation in the Crankcase

Some water, of course, may also be condensed from the air within the crankcase, for under normal conditions of design air has full access through the crankcase breather.

Here again the variables involved will preclude even an approximate estimate of how much water to expect. It will depend upon the moisture content of the air, the weather, the altitude, the atmospheric temperature, and the frequency of starting and stopping.

Water Indicated by Misfiring

Water in the carburetor is indicated by misfiring. In this event the carburetor drain should be opened to remove any slugs of water that may be present. It would also be advisable for the motorist to inspect his tank thoroughly for the presence of water; and if necessary drain the gasoline from the system and strain it.

Separation of Water

Unless a device specifically designed for removal of water from the oil in service is installed, emulsification and sludge formation can be the normal expectation. But these developments will, of course, not occur as rapidly with new or comparatively fresh oil

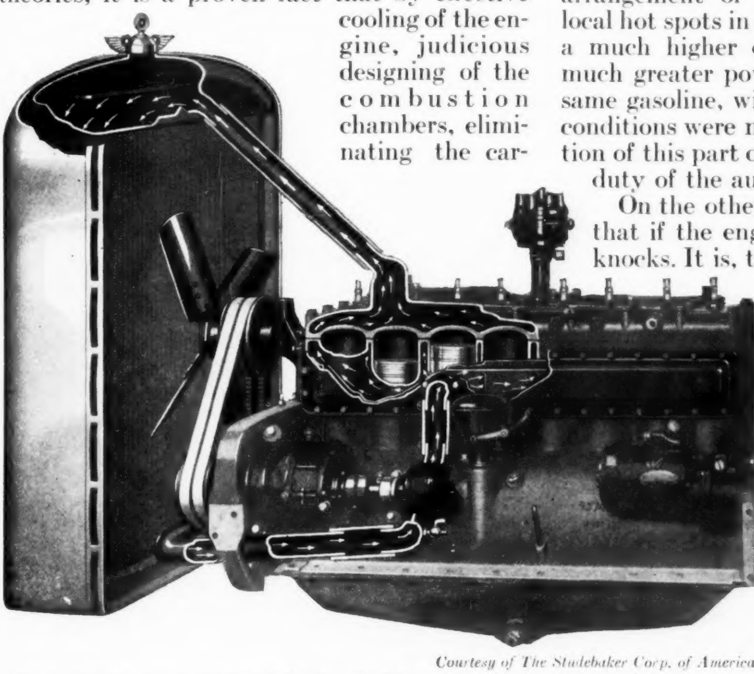
as later on when the oil has been in service for perhaps several hundred miles.

KNOCK

The development of knocking is probably one of the most widely discussed subjects in automotive circles, involving the relation between the engine and the fuel. It is unique inasmuch as although the fundamental reasons behind the reaction are not thoroughly understood it is still possible to control its occurrence or degree of intensity by judicious study of engine design and fuel refinement.

Every motorist knows that when his engine gets hot, when he subjects it to extra load at slow speeds, or when it accumulates carbon deposits in the combustion chamber each explosion may be accompanied by a sharp metallic sound which gives the impression that the engine is breaking apart.

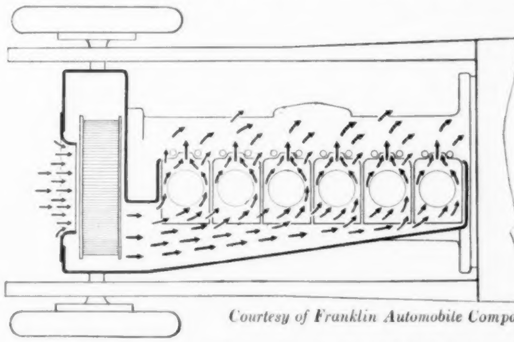
This knock or "ping" is entirely different from the "thump" of an engine wherein there is preignition, bearing knock or piston slap. As mentioned above, however, the cause is not definitely known. Some authorities claim that it is due to the over-rapid burning of the fuel; others, with equally good supporting data, claim almost the opposite. Regardless of these theories, it is a proven fact that by effective cooling of the engine, judicious designing of the combustion chambers, eliminating the carbon, or by changing the character of the fuel, knock can be eliminated.



Courtesy of The Studebaker Corp. of America

Fig. 6—Showing details of a Studebaker Straight 8 bus engine. Note in particular the cooling water system and course followed by the water in its flow through the engine.

Research has further shown that a few degrees difference in the temperature of the engine will make a great difference in knocking. The hotter the engine the greater the tendency to knock with any fuel, so it is advisable to keep the engine temperature down if knocking is to be prevented. Of course, there is a limit to which this can be done, inasmuch as too low engine temperatures result in incomplete or varying combustion of the fuel, and loss of power.



Courtesy of Franklin Automobile Company

Fig. 7—Top view of air cooling system of a Franklin in-line air-cooled engine. A turbine fan, mounted on the forward end of the crankshaft is the only moving part of this cooling system. Air is forced at high pressure into a scientifically shaped duct, which distributes the flow properly to each cylinder. After passing between the cylinders the air spreads out to cool the exhaust side before leaving the engine.

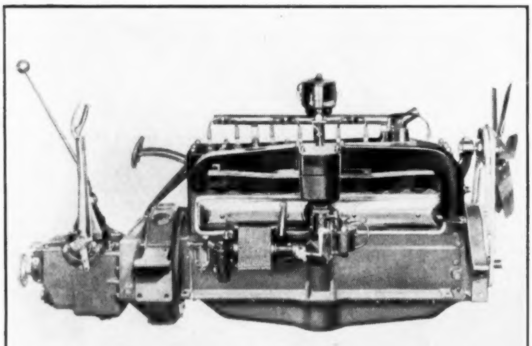
Many experimenters have found that by changing the design of the cylinder space, rearrangement of spark plugs, cutting out of local hot spots in the combustion chamber, etc., a much higher compression ratio and hence much greater power can be obtained with the same gasoline, without knocking, than if these conditions were not watched closely. The solution of this part of the problem is essentially the duty of the automotive industry.

On the other hand, every motorist knows that if the engine gets dirty with carbon it knocks. It is, therefore, his duty to keep his engine clean, not only to prevent knocking, but also to prevent the carbon formation from breaking up and getting into the lubricating oil, as well as working past the rings and causing abrasion.

Even if the above points are not taken care of, however, knocking can be prevented to a certain extent by the character of the fuel used. Some gasolines are more potent than others in the prevention of knock, and there are certain materials like tetraethyl lead and benzol which can be added to gasoline to prevent knocking. Nevertheless, the whole onus of the problem should not be left to the oil industry, but should be shared at least equally by the automotive industry, through the use of proper design.

Engine Construction and Lubrication

To attain maximum power output from the firing of any grade of gasoline in an automobile engine, one of the most important factors is proper functioning of the piston rings, for dependence is placed on the rings to prevent loss of compression, blow-by of combustible fuel vapors, and pumping of oil into the combustion chamber. To insure the greatest degree of seal the rings must be able to expand readily in the piston grooves and follow the cylinder bore at all speeds and under varying temperatures. As a result, the bore should be smooth and absolutely cylindrical, otherwise the rings may wear excessively in their respective grooves. Such wear will lead to ultimate impairment of the seal.



Courtesy of Pierce Arrow Motor Car Company
Fig. 8—Side view of a Pierce Arrow Straight 8 engine.

While a close fit is essential, it is important that the rings shall not bind under any operating conditions. This must be given especial consideration in warm weather where engine temperatures may be increased and the viscosity of the oil film proportionately reduced. Otherwise the value of the rings as a sealing medium may be affected. There must, furthermore, be an accurate fit between the cylinder bore and piston, with the minimum clearance practicable.

GRADE OF OIL A FACTOR

If, however, piston rings are to expand and contract readily in the piston ring grooves it is essential that a high grade of motor oil be employed. This latter should leave a minimum amount of carbon residue, so as not to impede the movement of the rings. The use of the proper grade of oil, commensurate with climatic conditions, will be insurance against stuck piston rings, for the amount of carbon deposit will be so small that there will be but little possibility of any accumulation behind the rings.

It is interesting to note that where heavy carbonization occurs a piston ring will be converted into a reamer, to cut the polished surfaces of the cylinder bore and permit passage of an excessive amount of oil to the combustion chamber. There will also be dilution of the motor oil. This will depend on the piston speed, however. As a result, it is extremely advisable to give the most careful consideration to choosing the proper grade of motor oil according to a dependable recommendation chart, for it will minimize power losses and faulty engine operation. In this connection, however, it must be borne in mind that these recommendations are based on new car construction; as an engine becomes older, clearances will have been increased. For such cars, a somewhat heavier grade of oil should be chosen.

Bearing Clearance must be Adequate

Bearings, also, occupy a position of prominence in modern automotive engine design. In this connection, much attention has been given to the relative merits of oil groove location, as well as the importance of properly fitting bearings, in order to insure continued and effective lubrication.

Although it has long been recognized that such bearings should have sufficient clearance to permit ready circulation of the motor oil, it is still frequent practice when overhauling engines to take up on the connecting rod caps and main bearings so tightly that a film of oil cannot penetrate between the contact surfaces of the rotating elements. The ultimate result of such a condition will be heat generation, with the possibility of a burned out bearing.

In general, it can be stated that an engine bearing will be destroyed only because of certain direct reasons, viz.:

(a) The lack of oil.
(b) Hammering out of the bearings where a connecting rod or main bearing cap has become loose, or
(c) Crystallization of the bearing metal.

By lack of oil is meant failure to provide an oil film in order to separate the two metallic surfaces to be lubricated. This applies to engines where oil supply has been completely consumed, as well as to cases where a full supply of oil is carried, but for some reason it does not reach the bearing surfaces. This latter may be caused by an oil pump being out of order, a clogged strainer or the fact that the bearings have been fitted so tightly that oil cannot penetrate between the bearing surface and the journal.

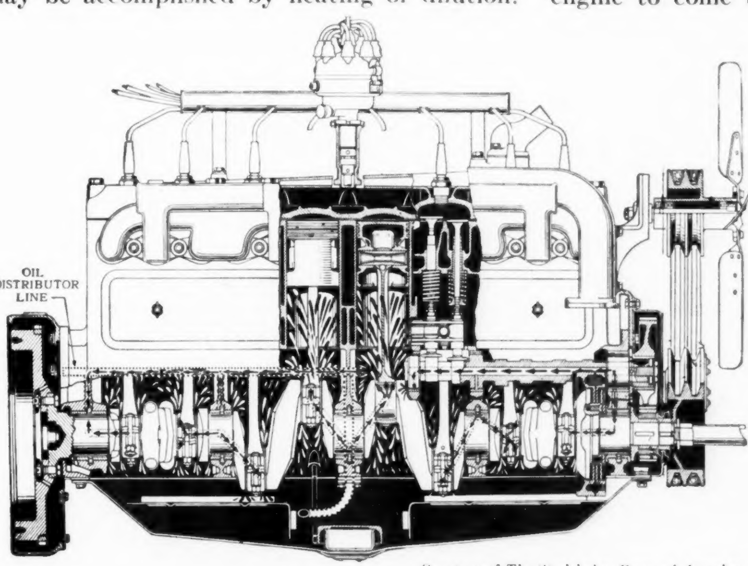
OIL GAUGE PRESSURE

In this connection oil pressure as shown by the dash gauge must also be considered. The function of this gauge is essentially to indicate that engine lubrication is being maintained. It is not a means of determining the amount of oil delivered to the various wearing parts, but rather the resistance to pumping involved.

Oil gauge pressure will therefore vary according to the viscosity or relative fluidity of the oil. Oil pressure drop will frequently cause worry to many motorists. It should, however, only be regarded as an indication of impaired lubrication provided pressure is lost entirely, for this may mean a broken or inoperative pump.

With the natural reduction in body or viscosity which is attendant to normal engine operation, resistance to pumping will be proportionately reduced. A certain amount of drop in pressure, especially during intensive or warm weather driving should, therefore, be expected.

In other words, the lighter the oil, the more easily will it pump and circulate, requiring less pressure. Reduction in body or viscosity may be accomplished by heating or dilution.

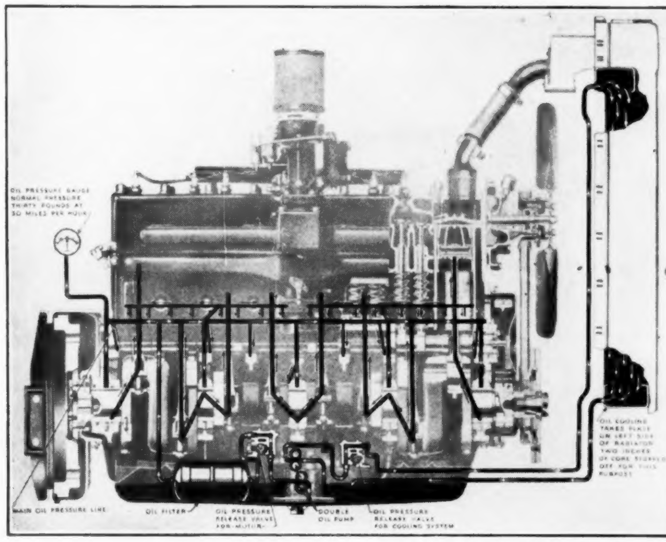


Courtesy of The Studebaker Corp. of America

Fig. 9—Sectional view of a Studebaker Straight 8 bus engine, showing the oil distribution line and details of oil flow through the crankshaft and other bearings into the cylinders.

As a result, if the pressure drops too low it will be an indication that the viscosity of the oil is too low to meet the operating temperatures involved. The reason may be that originally the oil was too light, or that an excess of dilution has occurred.

The remedy is, of course, to use more care in original selection of the oil according to chart recommendations, and to operate with as lean a fuel mixture as possible. Reduced choking,



Courtesy of Hupp Motor Car Company

Fig. 10—Oil chart of the 133 H.P. model "H" Hupmobile engine showing complete distribution of oil. This chart also shows the flow of oil from a second oil pump in the engine sump to the radiator and return.

the least amount of idling, and allowing the engine to come up to operating temperature before putting any load on it, all aid largely in this regard. The engine should, however, never be raced during the warming up period.

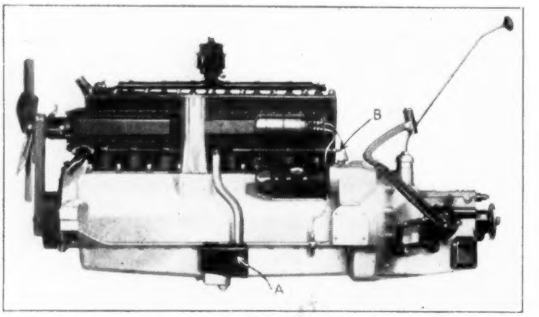
It will be obvious, therefore, that high or rising gauge pressure should be of far more concern to the motorist, for it may be an indication of faulty lubrication due to a clogged oil line, or the oil being too sluggish and heavy to pump readily and distribute freely to the bearings, or splash to the cylinder walls, according to the system involved.

MEANS OF LUBRICATION IMPORTANT

In accordance with the theory and practice of lubrication it has been developed that an adequate film of oil between any two surfaces to be lubricated will effectively prevent wear of

the respective moving parts, provided that film is continuously maintained during operation.

The means of lubrication is of course important in this regard. If positive circulation of an adequate volume of oil is practicable, and if the oil has been carefully selected as to properties which will render it capable of functioning under the prevailing operating conditions there should be no geographical relationship between the source of the crude from which this oil has been refined and the amount of wear which may result in the normal operation of an internal combustion engine.



Courtesy of Packard Motor Car Company

Fig. 11—View of a Packard engine, showing in particular at A, means for crankcase ventilation, and at B the system for cylinder wall lubrication when starting.

Where it is impossible to maintain a suitable film of oil due to ineffective means of lubrication, or road dust or other foreign matter gaining entry into the engine and becoming absorbed by the lubricating oil, wear will result between the rotating or reciprocating parts regardless of the original purity, source or characteristics of the oil.

Research has indicated that the presence of abrasives such as road dust, hard carbon, etc., is responsible for the majority of all engine wear. Other causes such as metal fatigue or vibration are relatively minor.

RELATION OF VISCOSITY TO TEMPERATURE

In view of the fact that the viscosity or body of any oil is directly affected by temperature, this characteristic must be thoroughly understood wherever oils are to be selected to meet warm weather operating conditions.

It is a characteristic of most liquids to become thinner or more fluid when subjected to an increase in temperature. For the information of the layman, in the petroleum industry this is termed reduction in viscosity. It will be of further advantage to state that viscosity is regarded as a measure of the relative fluidity of an oil at some definite temperature of observation. In brief, it is that inherent property by virtue of which the flow of certain liquids will be retarded. It is possessed by all lubricating oils to a varying degree, depending on their source, range of distillation, and extent of refining or blending.

As a result, wherever abnormally high or low temperatures must be encountered, the operating viscosity of the lubricant must be given the most careful consideration. Simply because the temperature of the lubricant may be more or less controlled prior to application or circulation to the wearing elements is no criterion that its operating viscosity in service will be able to maintain an adequate lubricating film. Attention must be given to the operating temperatures, and the original oil selected with this in view.

It is perfectly evident that our modern conditions of higher automotive engine temperatures will lead to an increase in the degree of fluidity of the oil which is used for lubrication. Especially will this be true in warm weather, when the amount of external cooling will be appreciably lower than in cold weather, or under lower atmospheric temperature conditions.

This will call for the utmost care in the selection of the proper grade of lubricating oil for warm weather operation. Haphazard choice without adequate knowledge of the approximate operating viscosity of the proposed oil may be the forerunner of too great a variation in the fluidity of the oil in service, with oftentimes ineffectual lubrication of certain of the wearing parts. The ultimate occurrence of scored or burned out bearings, of abnormal wear on cylinder walls, and an excess of oil pumping past the piston rings, will all lead to increased cost of maintenance and a natural decrease in power output or engine efficiency.

THE EFFECT OF CARBON RESIDUE

Carbon is an essential component of all petroleum products, and therefore must pass through every automobile engine. It is only a detriment, however, in the form of soot or deposits of carbonaceous tarry matter. This may of course have a very decided effect upon the operation of the engine, the amount of power developed and the amount of "knocking," according to the extent to which carbon deposits are formed on the spark plugs, pistons, cylinder heads, around the rings, on valves and valve seats, and in the crankcase.

Heat a Factor

The amount of ultimate carbon will depend entirely upon the degree of heat present, the extent of refinement of the lubricant and the base of the crude from which it is made. From particular types of crude for example, distillates

can be produced which will show an almost negligible carbon residue.

All true carbonaceous deposits in the average automotive engine do not, however, originate from the lubricating oil. Incomplete combustion of the gasoline or an abnormal amount of dilution of the lubricating oil will also tend to increase the amount of carbon formation in the combustion chamber. In other words, the lighter the lubricant or the thinner the film on the cylinder walls, the more readily will it splash or succumb to the pumping effects of the piston. This will, of course, increase the possibility of forcing of the lubricating film up into the combustion chamber where it will be ultimately burned. The direct result is the development of more or less carbon.

How extensive these deposits may be will, of course, depend upon the residual carbon content of the oil. Where the latter burns cleanly the amount of such deposits will be relatively small. Furthermore, if the oil is properly refined and adapted to the purpose such carbonaceous matter will be soft in appearance, low in quantity and easily removed when cleaning is necessary. Over extended periods of operation, however, carbon deposits whatever their nature, will be bound to increase.

How Excess Lubricating Oil May Act

Just how an excess of lubricating oil may cause abnormal carbon deposits will be of interest. Theoretically a very small amount of oil is necessary to maintain the requisite lubricating film on the cylinder walls and serve the respective bearings; actually, however, a considerable excess of oil will be used. Where the rings give the proper degree of seal and the cylinder walls are not abnormally worn, but little of this oil should pass to the combustion chamber. If the oil level is carried too high, however, especially in oiling systems involving splash lubrication, the amount of oil on the cylinder walls may be so excessive that a certain percentage cannot help but find its way into the combustion chamber. A smoky appearance of the exhaust will frequently be an indication of this.

PREVENTION OF OIL CONTAMINATION

Impairment of lubrication by entry of abrasive foreign matter or materials which may interfere with the functioning of the lubricating system must, of course, be prevented at all times. As a result, we must guard against:

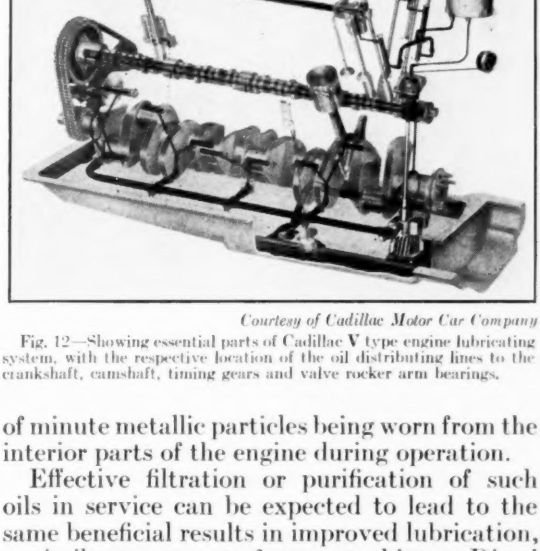
1. Entry or accumulation of abrasive dust along with the air which is essential to combustion.
2. Development of carbonaceous matter when lubricating oils are exposed to high operating temperatures on the upper parts of the cylinder walls, and
3. Dilution of the main body of oil in the crankcase by leakage of unburned gasoline past the rings.

This can be accomplished to a certain degree by improvements in engine design, to promote more complete combustion with better control of temperatures, as already mentioned.

In addition, however, the use of accessory equipment for the prevention of entry of dust, and the removal of carbonaceous matter, dirt, metallic particles and heavy gasoline ends and water of condensation is also decidedly practicable.

Oil Filtration

The oil filter is perhaps the most essential device, for the extent to which air may contain abrasive dust particles will depend to a great extent upon the character of the roadway and nature of the country traversed. As a result, whereas air contamination may vary widely, motor oils will always be subject to a certain amount of positive contamination, after a certain length of service in an engine, for abrasive dust may pass in through the crankcase breather, break-down of the oil or over-choking may develop carbonaceous residues, and there will always be the possibility



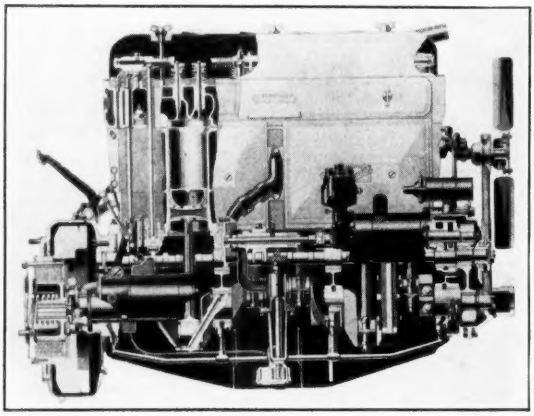
Courtesy of Cadillac Motor Car Company

Fig. 12—Showing essential parts of Cadillac V type engine lubricating system, with the respective location of the oil distributing lines to the crankshaft, camshaft, timing gears and valve rocker arm bearings.

of minute metallic particles being worn from the interior parts of the engine during operation.

Effective filtration or purification of such oils in service can be expected to lead to the same beneficial results in improved lubrication, as similar treatment of steam turbine or Diesel engine oils. Defective lubrication is more frequently the result of contamination and the inability of an oil to perform its intended function, rather than of faulty refinement, provided, of course, that the original product

conforms in characteristics to the specifications demanded by engine construction and the prevailing operating conditions involved. It is decidedly advisable to endeavor to protect the automotive engine by removal of dust, dirt or metallic foreign matter from the oil.



Courtesy of Buick Motor Company

Fig. 13—Sectional view of a series 40 Buick engine. Note in particular the oil pump in the base of the crankcase, the crankcase oil delivery pipe and the details of construction.

The properly designed oil filter should accomplish this. To expect, however, that the oil filter, as applied to individual treatment of automotive engine oils will insure indefinite longevity in the latter is erroneous. For the oil filter cannot be absolutely perfect, nor can it adequately remove all of that very fine carbonaceous content which is the natural result of subjecting such oils to the usual temperatures of combustion.

In consequence, filtering does not eliminate the necessity for oil renewal. It must be remembered that oils do not wear out, but that, due to the tendency toward incomplete combustion, their carbon residue content may become markedly increased. Such carbon is naturally of a discoloring nature, hence the rapid darkening of the new oil when put into service. Furthermore, carbon has but a negligible lubricating value; in fact, if hard and abrasive, it may easily lead to scoring of wearing elements. Actual combustion or loss of motor oil through vaporization at higher temperatures, therefore, requires the addition of makeup. Furthermore, frequent replacement should also be made in the interest of protection of the more valuable engine wearing parts, irrespective of the type of filter used.

Clean Air Also a Factor

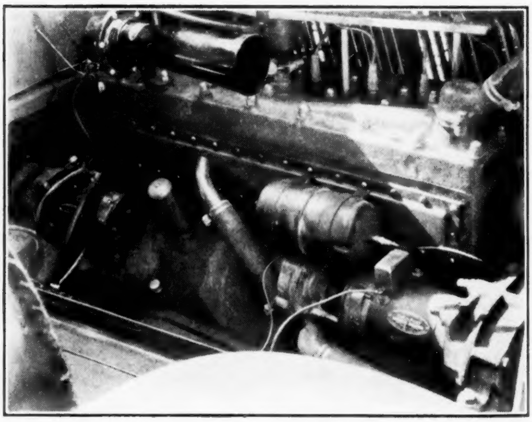
Engine lubrication will also be improved if steps are taken to insure the use of as clean air as possible, provided that motor oils of the requisite degree of purity and low carbon residue are used. This can be accomplished by properly passing the air necessary for combustion purposes through a filtering or separating medium capable of removing the greater part of the road dust content.

The amount of dust which may gain entry into an automotive engine will depend first of all upon whether or not an air cleaner is installed, and then upon the location, and efficiency of this latter. Of course, there are also certain other influencing factors, such as for example, the nature of the soil of the country being traversed, the amount of wind, the running speed, the type and size of fan installed, and the tightness of its belt. It is safe to say that research as carried out to date is indicative of the ultimate value of an air cleaner on practically any type of automotive engine.

CRANKCASE DILUTION

Crankcase dilution involves the thinning down of a motor oil. It is normally due to condensation or deposition of a certain amount of unburned fuel on the cylinder walls, this eventually reaches the crankcase, entering the lubricating system on account of the continued interchange of freshly sprayed oil with the oil film on the cylinder walls, and contaminating the main body of the oil.

The occurrence of dilution to any material extent may lead to impaired lubrication, due to the body or relative fluidity of the oil being too low at bearing operating temperatures to maintain an effective film between the wearing elements. Metal-to-metal contact with the development of abnormal friction may thereby result. Furthermore, the delivery of too thin an oil to the cylinder walls may lead to blow-by on account of imperfect sealing.



Courtesy of Auburn Automobile Company

Fig. 14—An Auburn 125 engine, showing the oil filler on the right side of the engine so that it is convenient to replenish the oil supply at the curb.

Dilution is especially influenced by engine temperatures. In brief the temperature of the cylinder must be sufficiently high to insure complete vaporization and burning of gasoline.

Printed in U. S. A. by
Edgar C. Ruwe Co., Inc.
72 Washington St., N. Y. C.